



Peculiar Supernovae in SDSS-II



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Ohio State University

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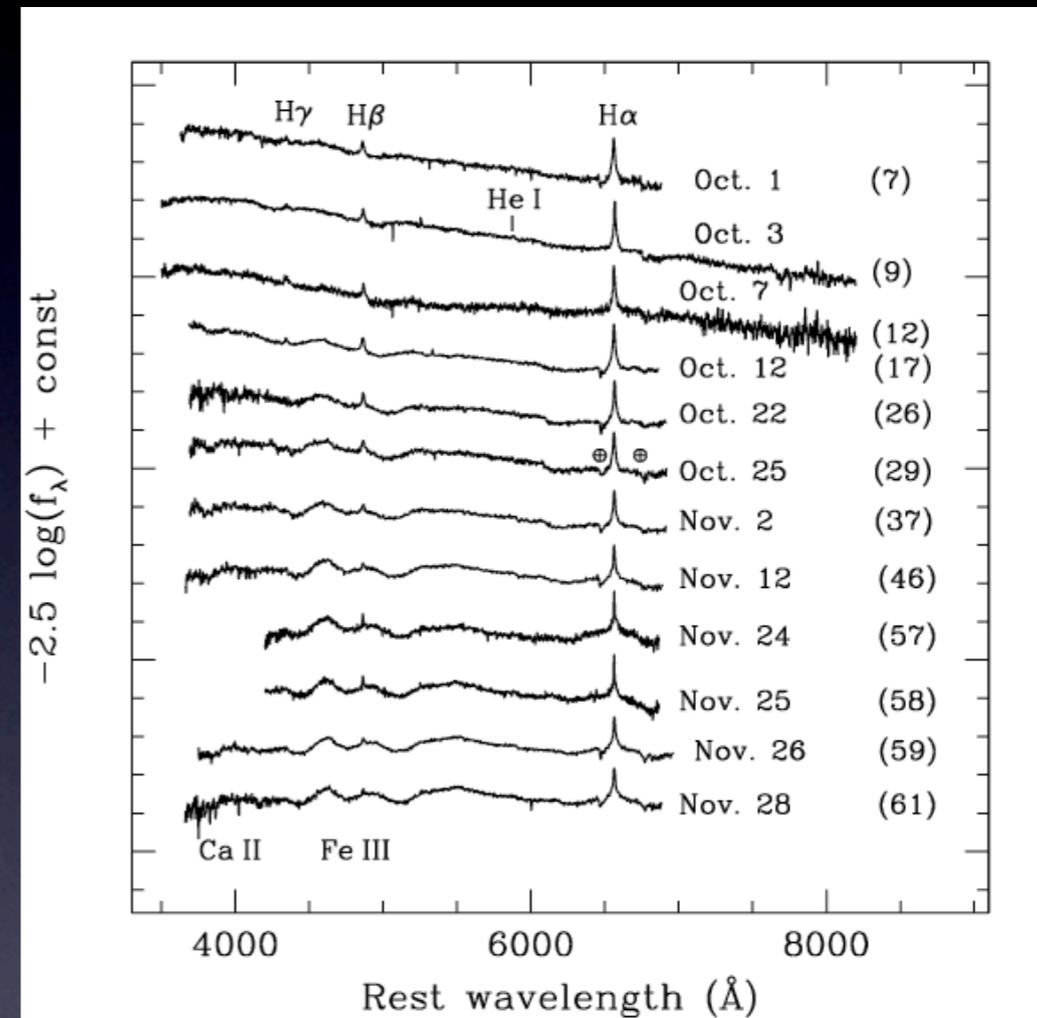
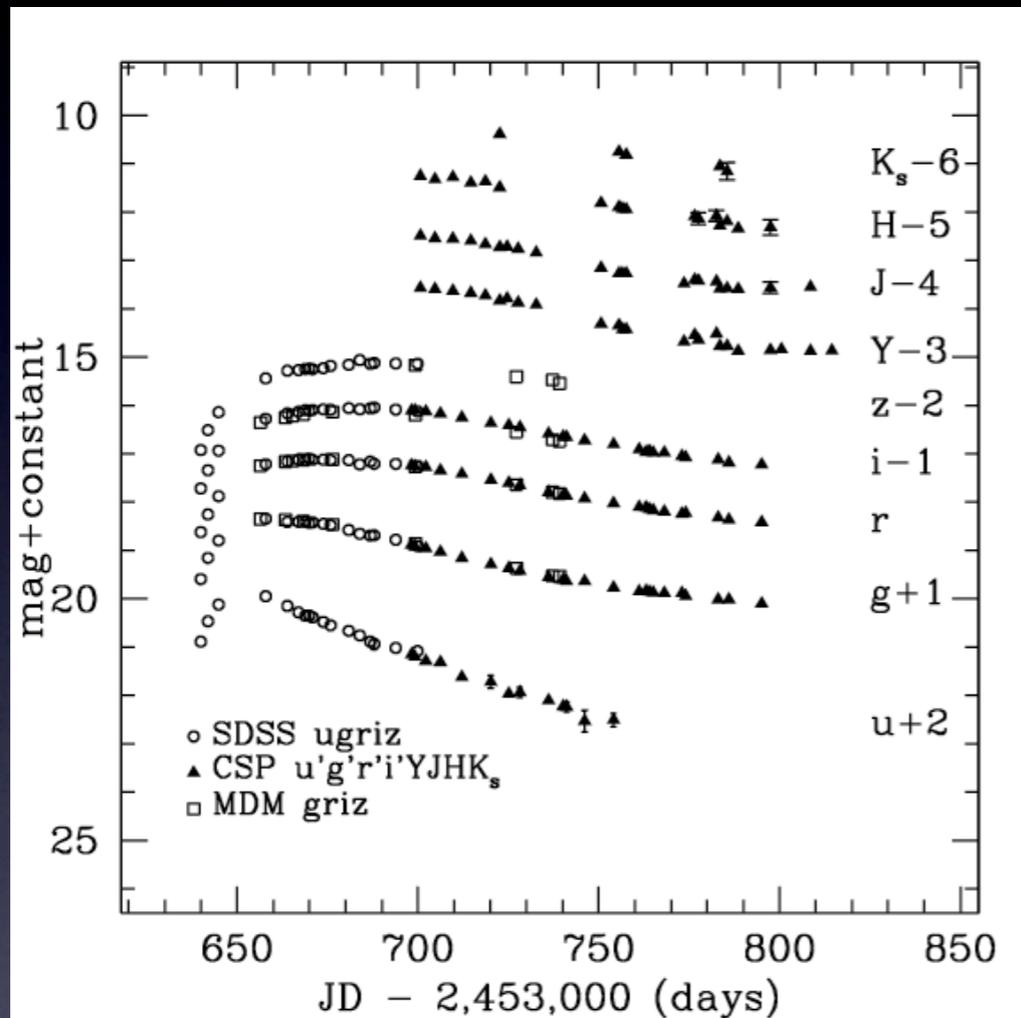
Introduction

- Large search volume and high efficiency of the SDSS-II Survey allows sampling most of the supernova types and properties, including peculiar events.
- Peculiar supernovae have photometric and/or spectral properties that are remarkably different from the objects in their class.
- During the 2005 search season two peculiar type Ia SNe were discovered by SDSS: SN 2005gj and SN 2005hk.

Supernova 2005gj

- Discovered on September 29, 2005 by SDSS and the Supernova Factory (astro-ph/0606499)
- First spectrum showed a blue continuum with Balmer lines in emission, like a type II_n SN, at redshift $z=0.062$
- Intensive photometric and spectroscopic follow-up showed evolution similar to SN 2002ic, the first clear case of type Ia strongly interacting with a dense circumstellar medium (Hamuy et al. 2001)
- 26 photometric epochs and 15 spectra (SDSS collab.)

Supernova 2005gj

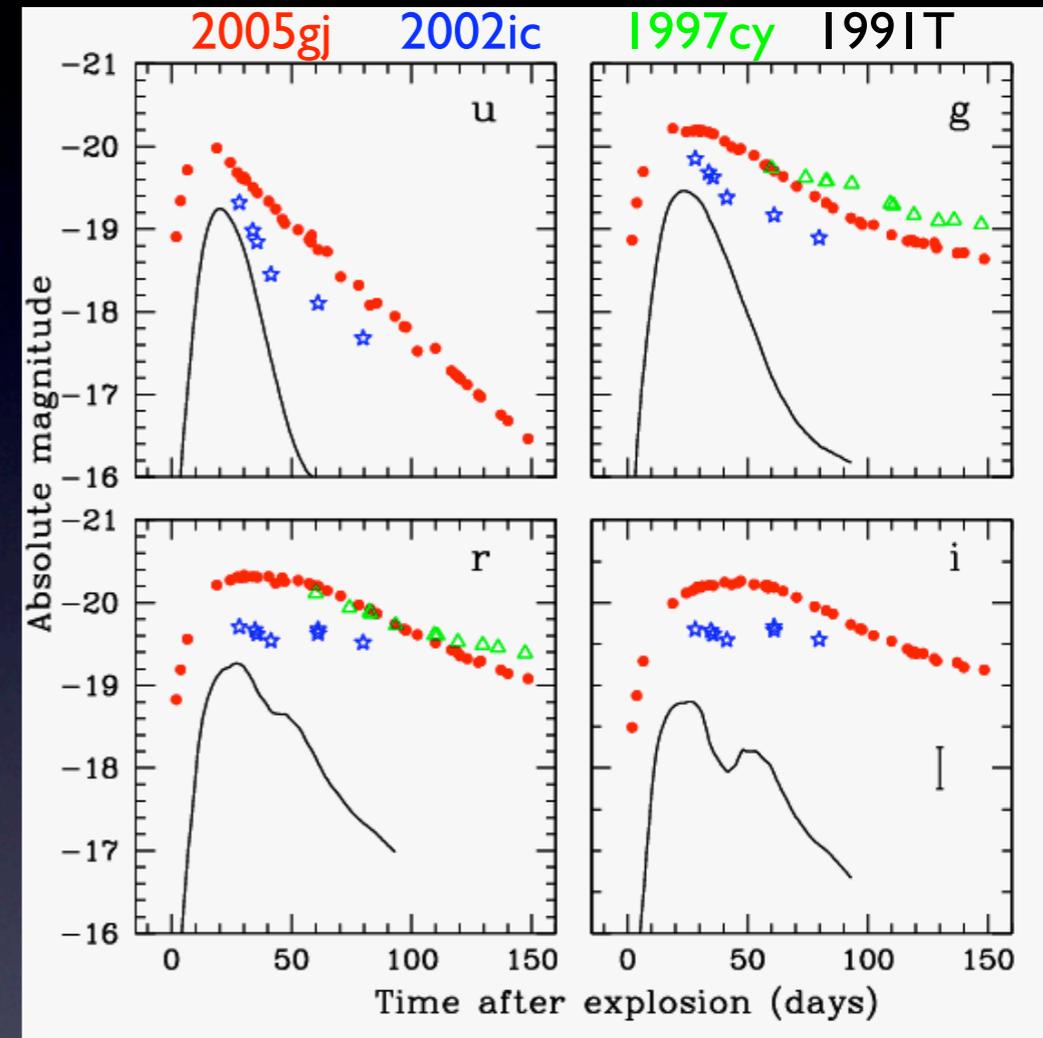


Optical + NIR follow-up
(SDSS-II and CSP)

Supernova 2005gj

Light curve properties:

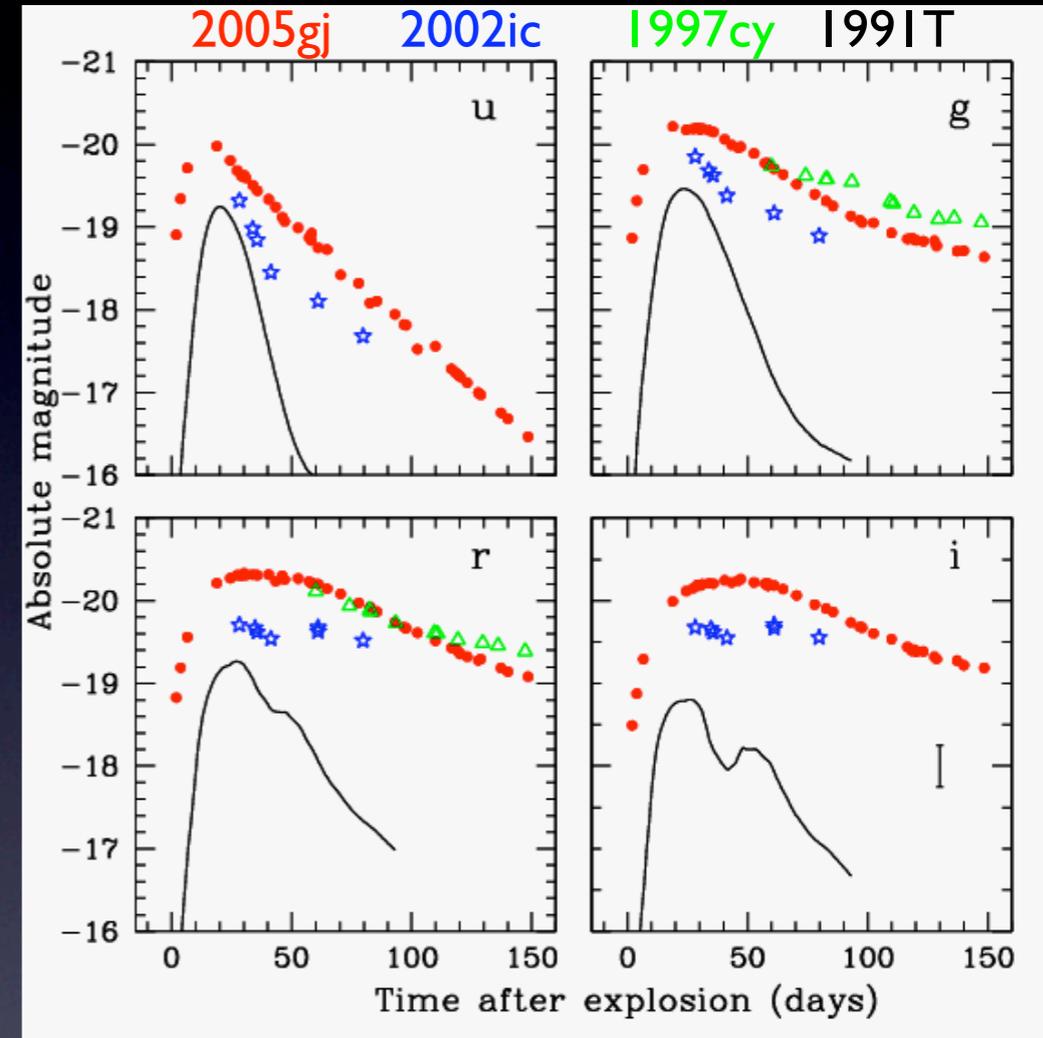
- Reaches maximum light between 14-47 days after explosion (*u* to *i* filters)



Supernova 2005gj

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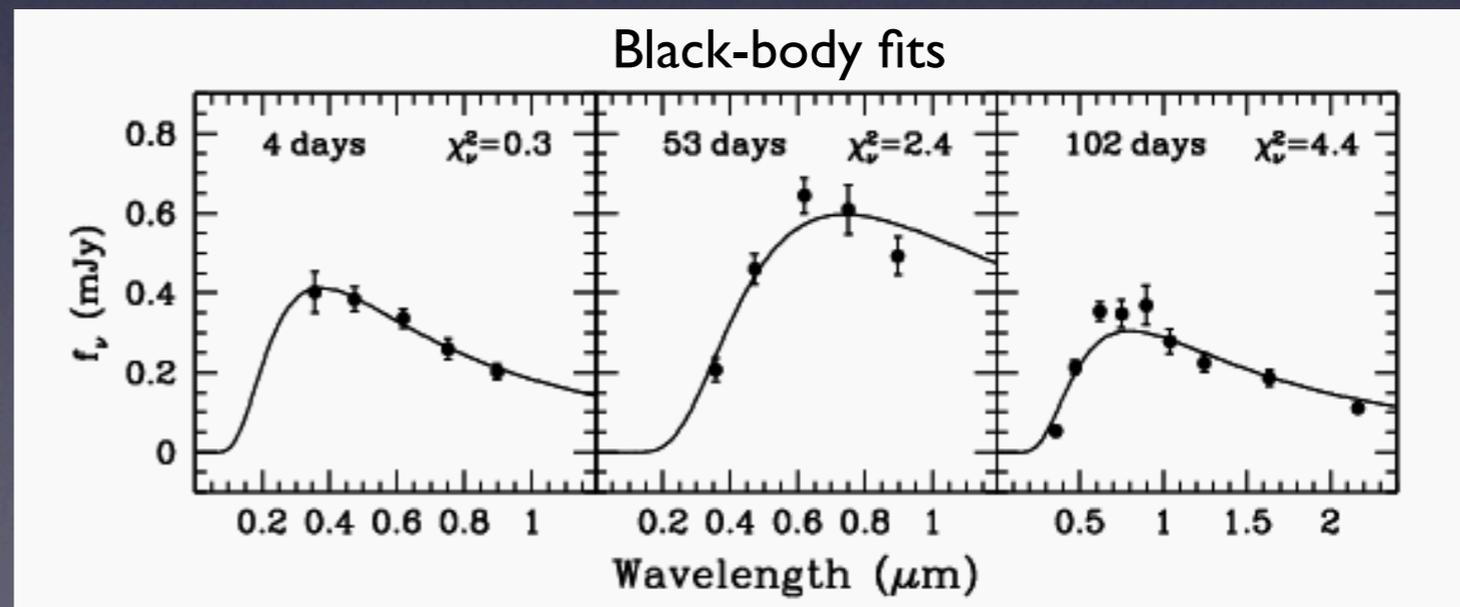
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- 3x the luminosity at maximum of SN 1991T and 1.5x more luminous than SN 2002ic



Supernova 2005gj

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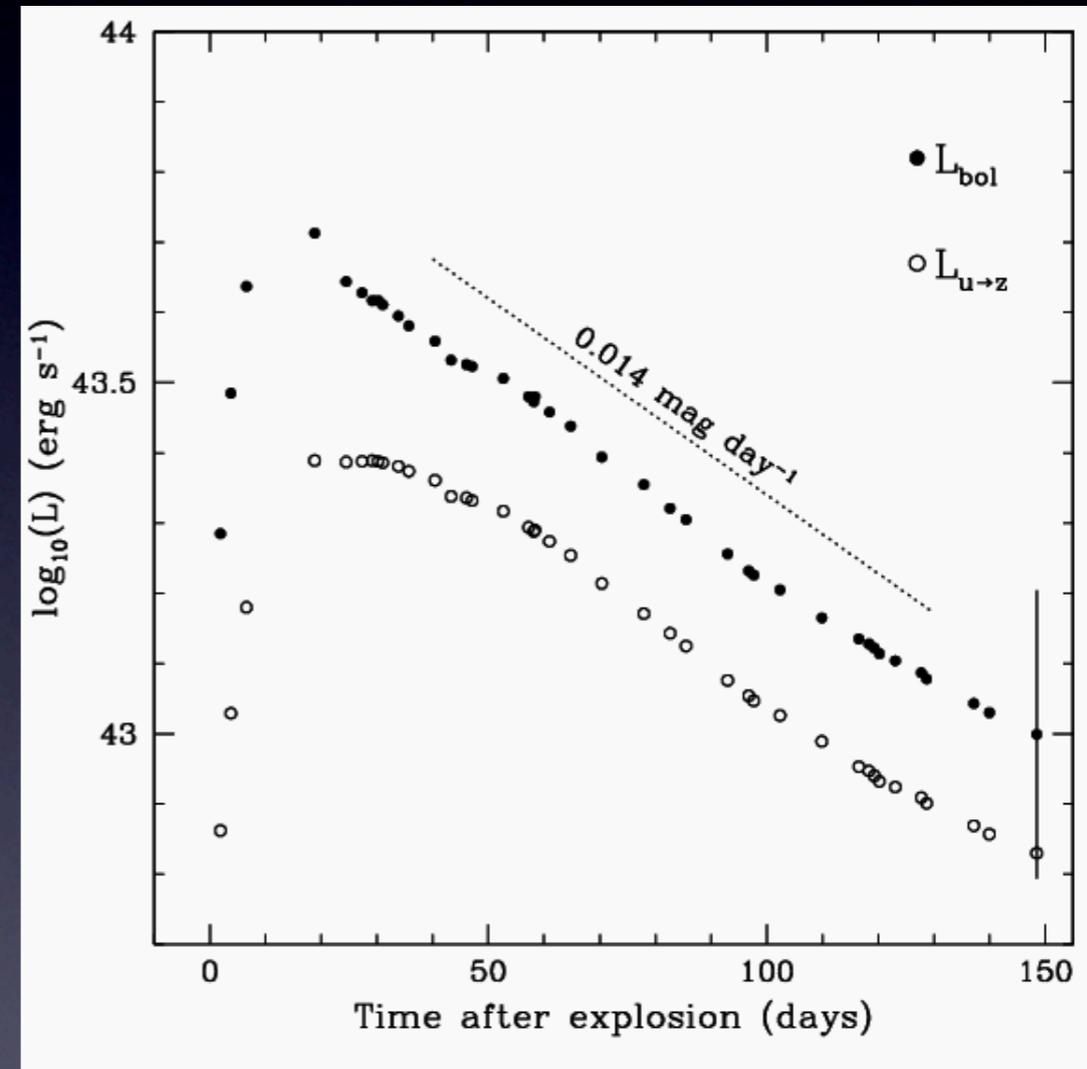
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- Rest-frame colors reasonably well described by black-body with a temperature evolution similar to type II_n SNe



Supernova 2005gj

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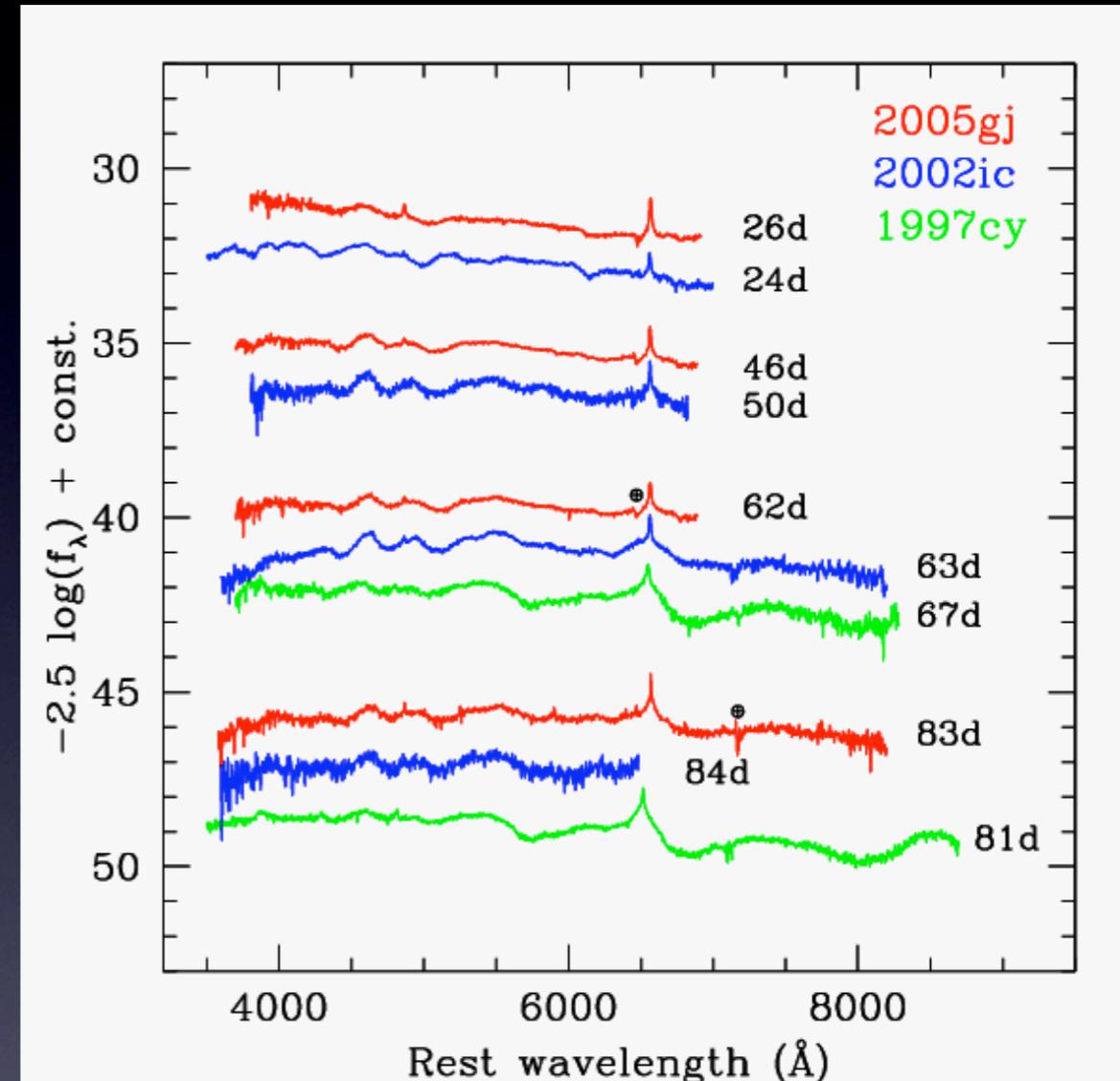
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- 3x the luminosity at maximum of SN 1991T and 1.5x more luminous than SN 2002ic
- Rest-frame colors reasonably well described by black-body with a temperature evolution similar to type II_n SNe
- Bolometric light curve declines linearly at rate 0.014 mag/day



Supernova 2005gj

Spectral properties:

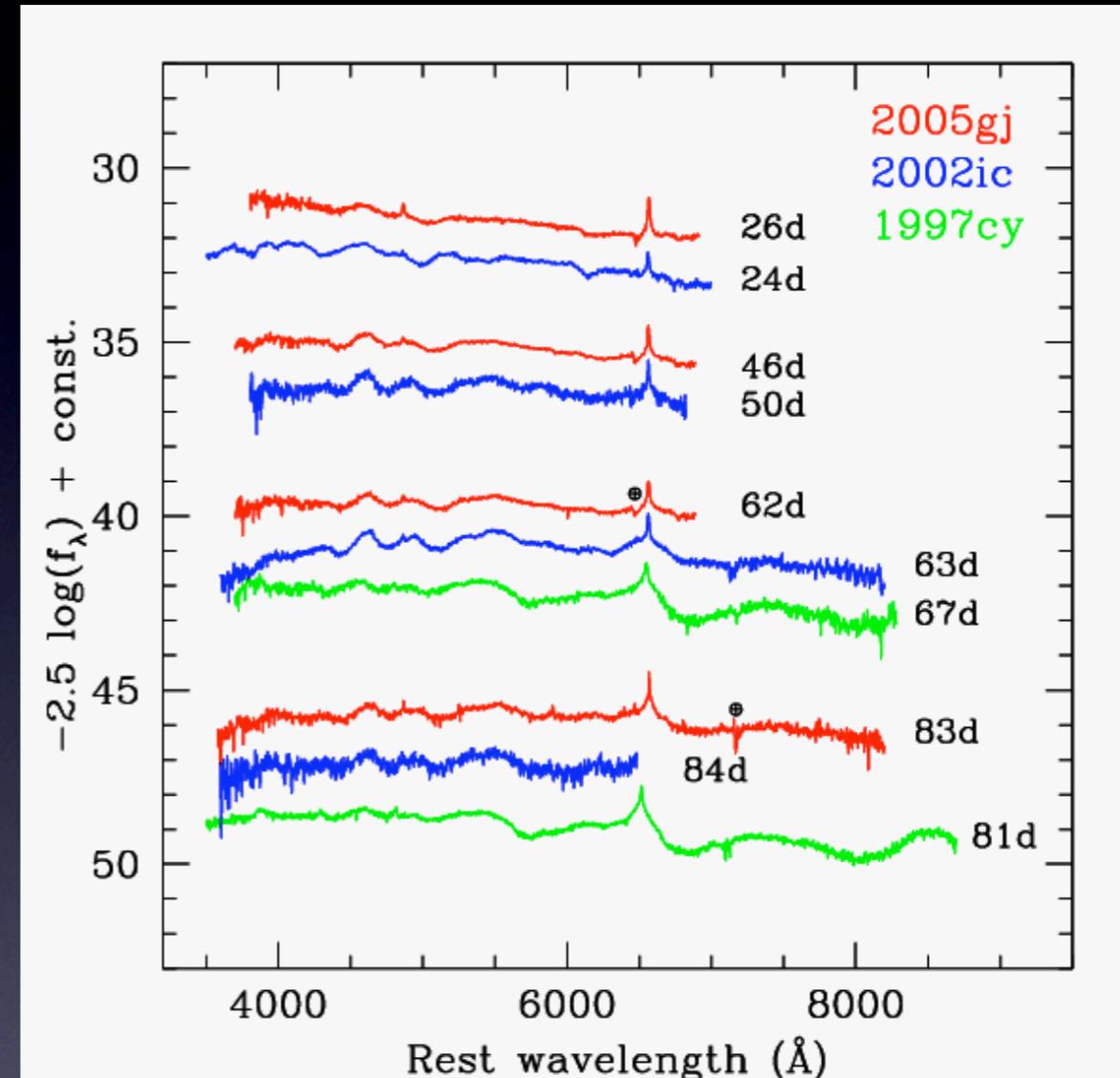
- Very similar to SN 2002ic and 1997cy at corresponding times after explosion



Supernova 2005gj

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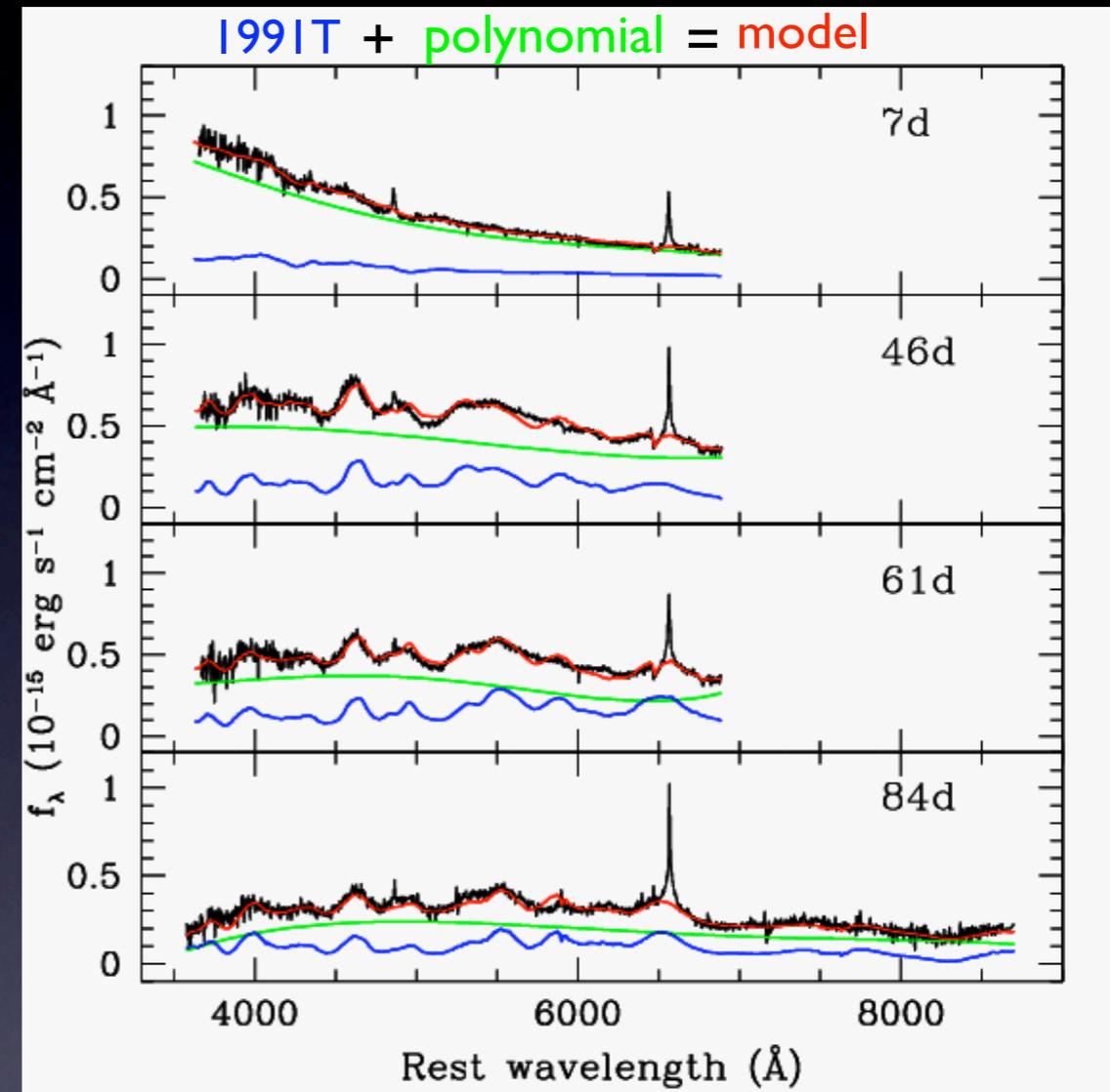
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- Balmer lines described by a combination of narrow (FWHM \sim 300-500 km/s) and broad (FWHM \sim 1800-2500 km/s) Gaussian components



Supernova 2005gj

Spectral properties:

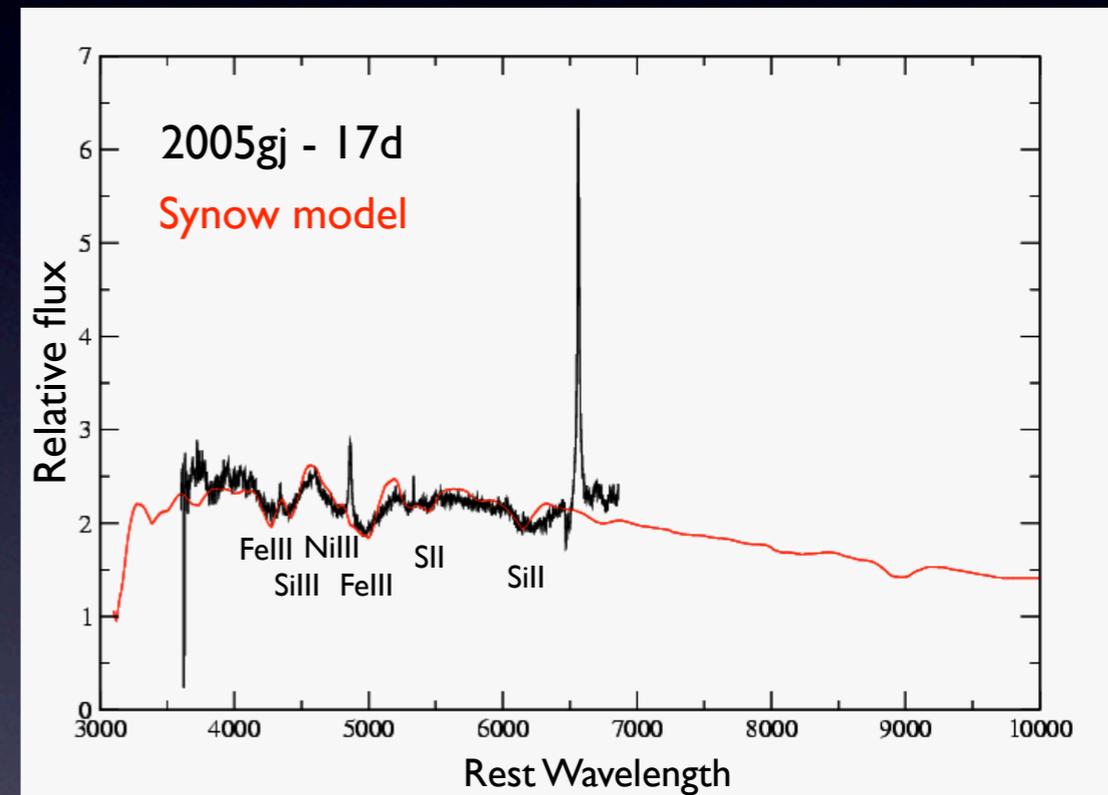
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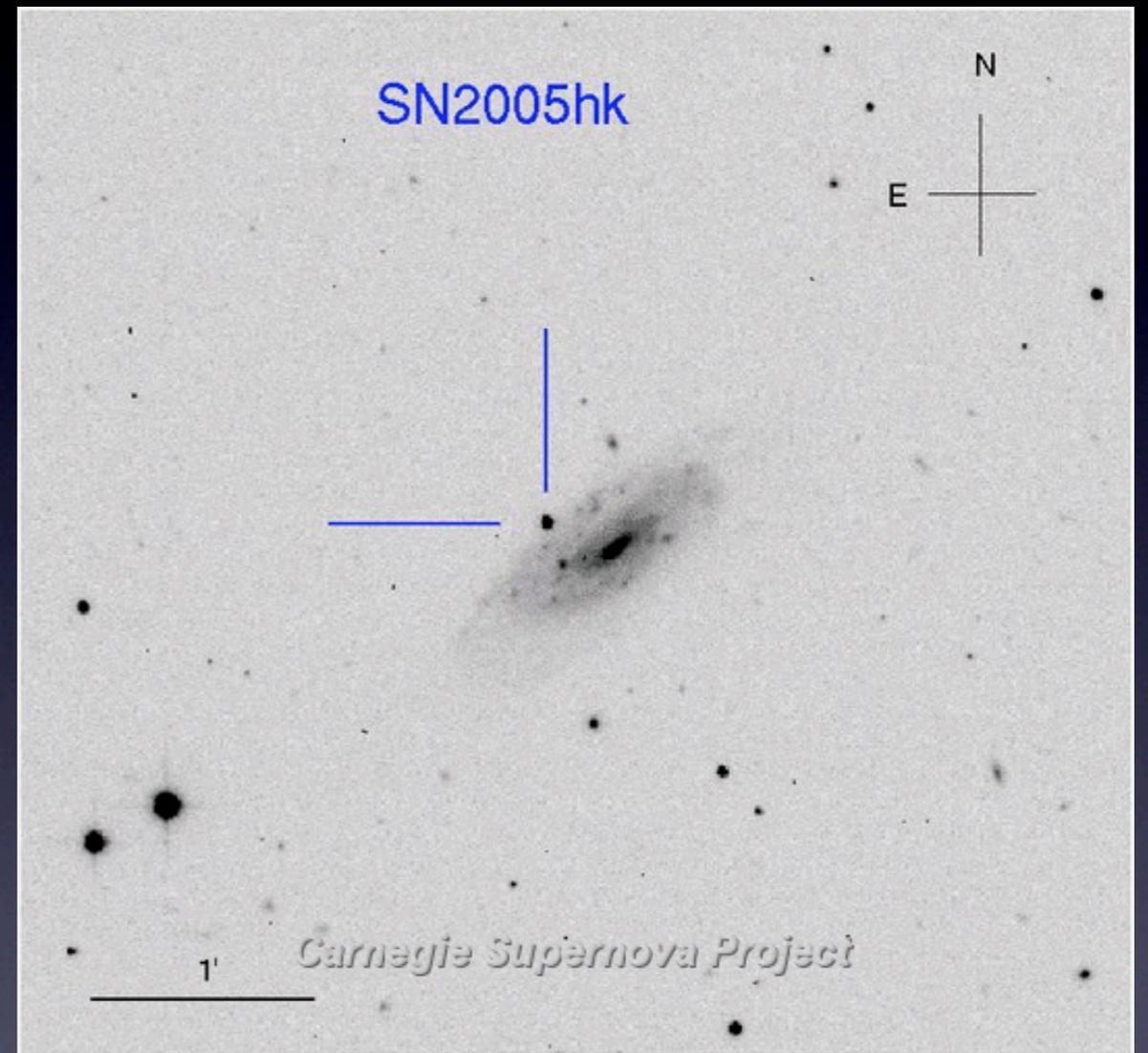


J. Parrent

- *Synow* modeling of the spectra near max gives a good fit using Fe III, Si II, S II, Ni III and Si III and characteristics similar to SN 1991T

Supernova 2005hk

- Discovered on September 28, 2005, in UGC 272 at $z=0.013$
- 16 photometric epochs and 7 spectra (SDSS collab.)

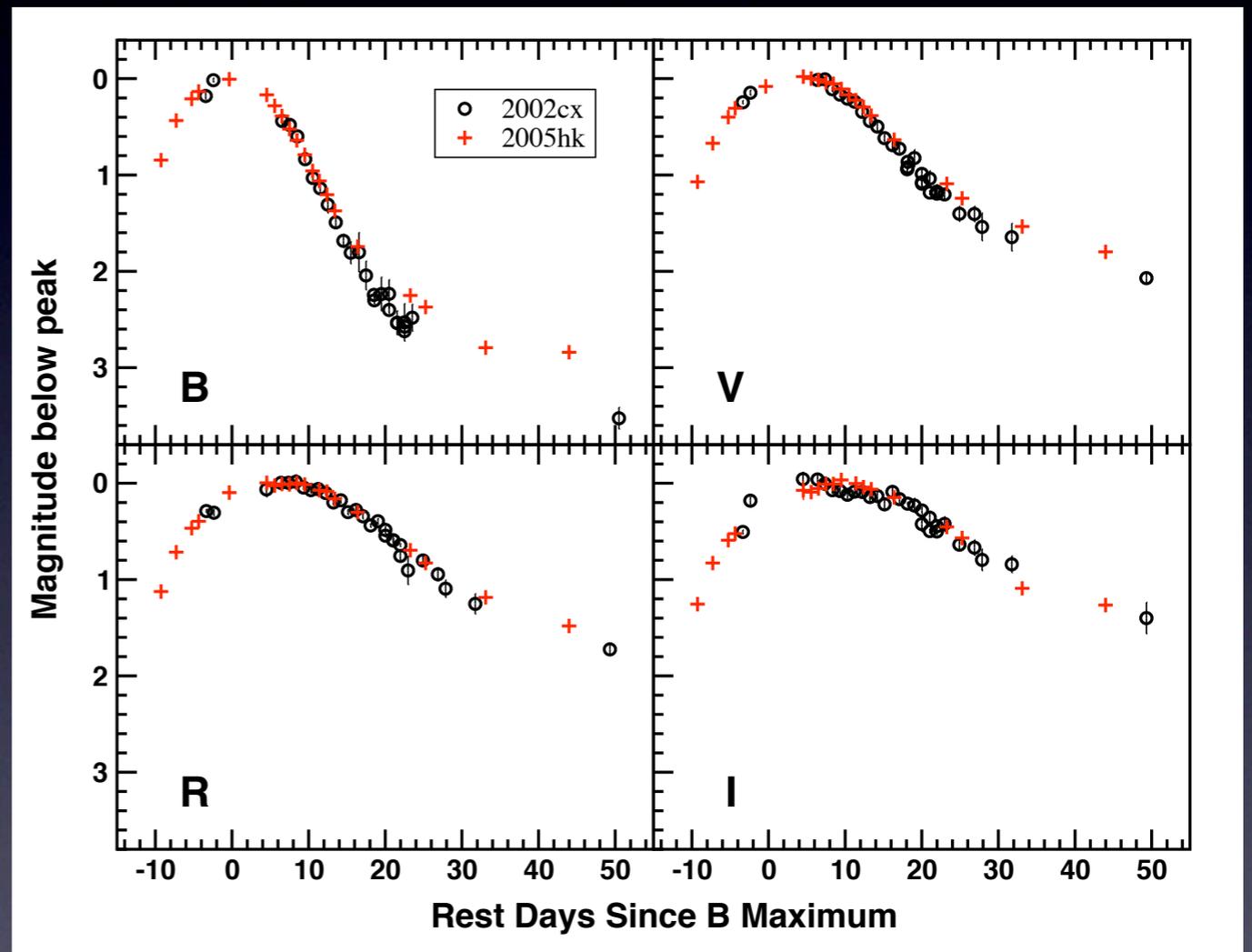


SDSS-II, CSP and LOSS

Supernova 2005hk

Light curve properties:

- Very similar to SN 2002cx

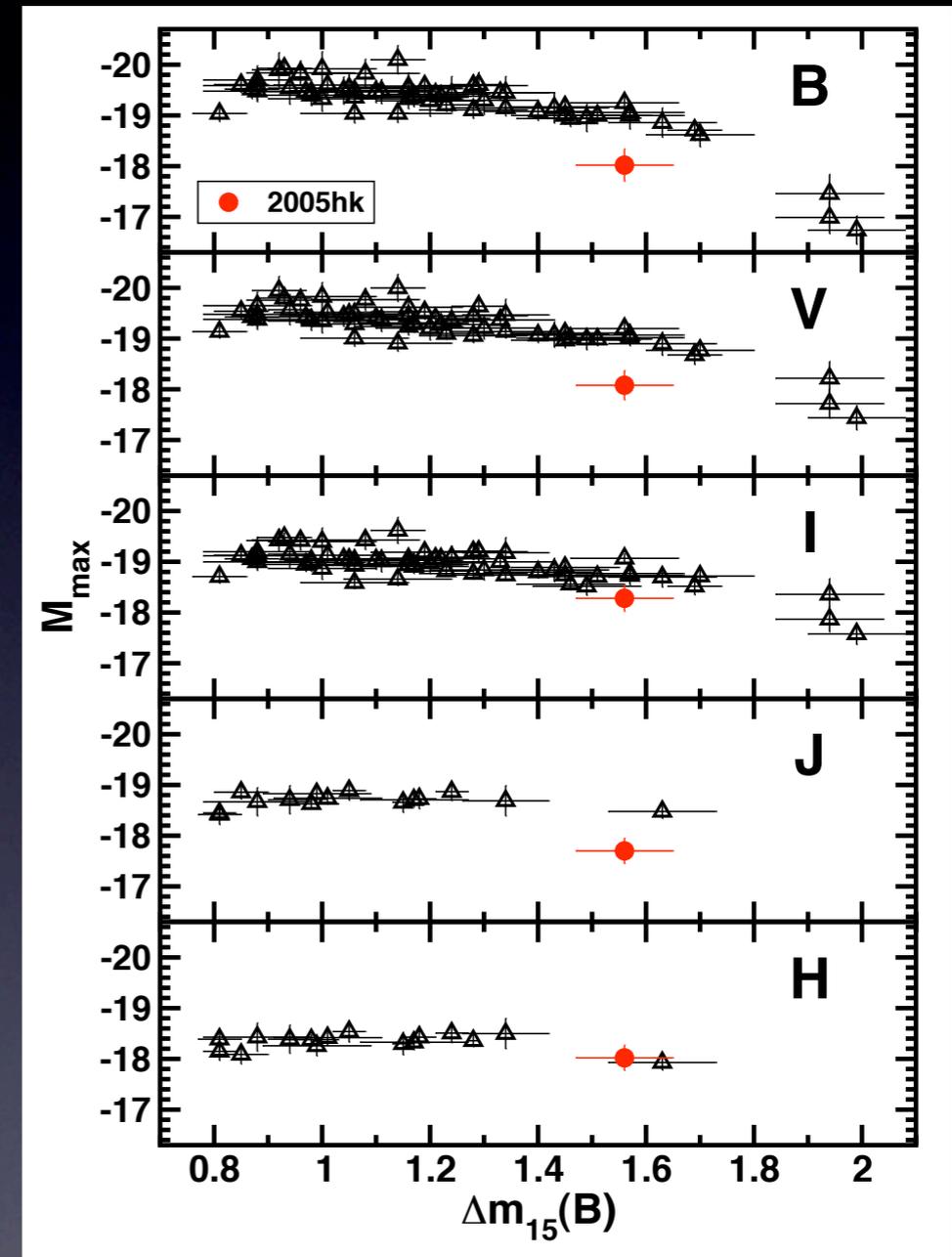


Li et al. 2003, Phillips et al. 2006

Supernova 2005hk

Light curve properties:

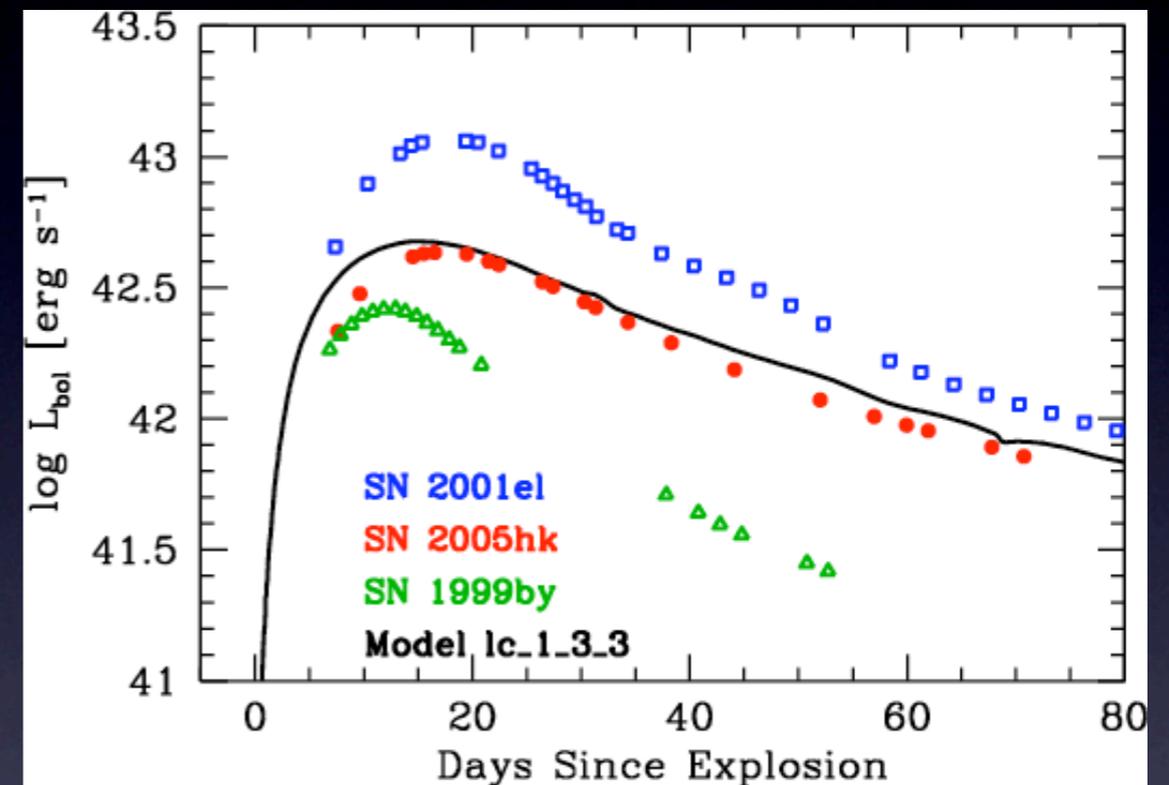
- Very similar to SN 2002cx
- Sub-luminous for its decline rate



Supernova 2005hk

Light curve properties:

- Very similar to SN 2002cx
- Sub-luminous for its decline rate
- Bolometric light curve well-fit with a 3D deflagration model with small amount of Ni 56

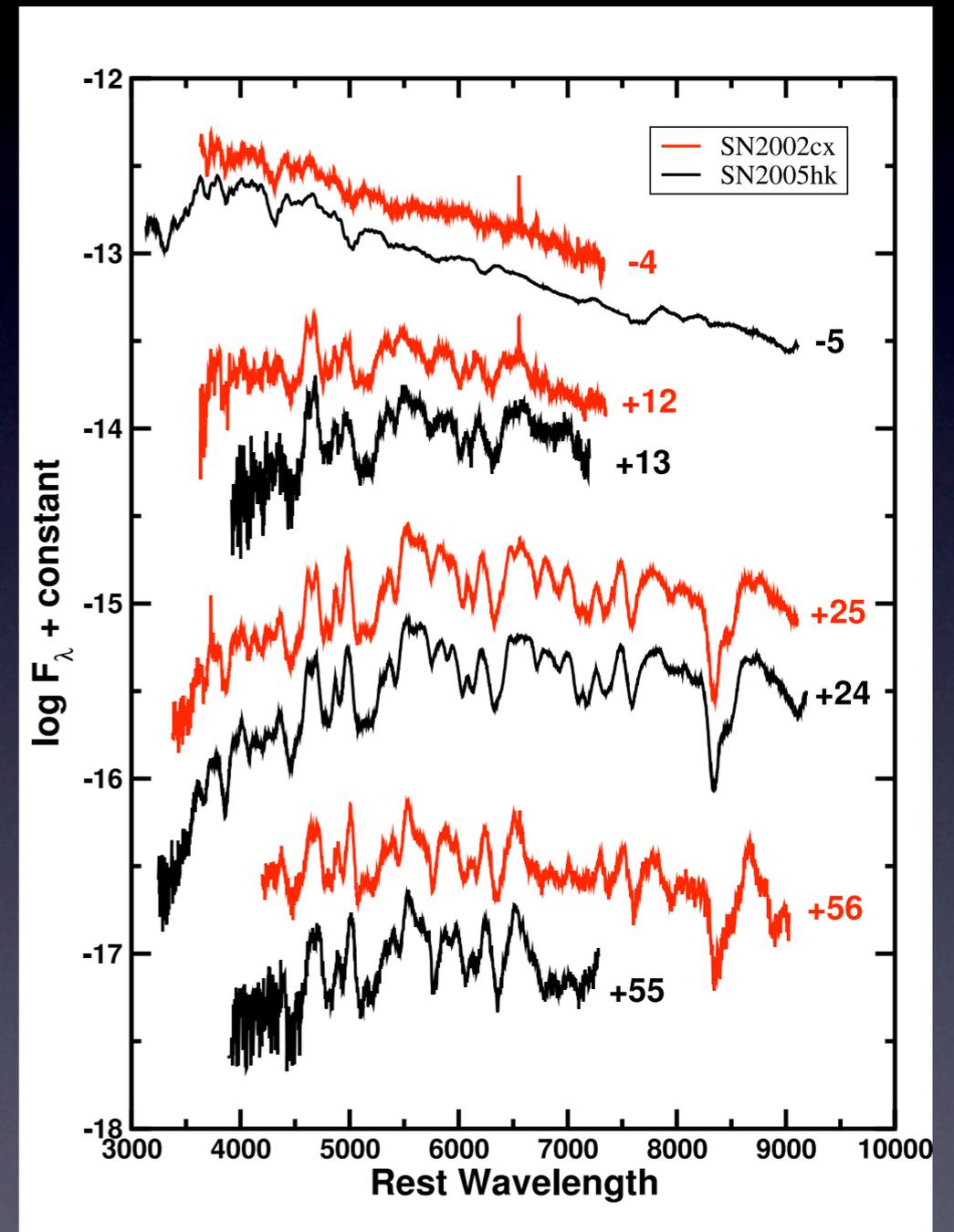


Phillips et al. 2006

Supernova 2005hk

Spectral properties:

- Very similar to SN 2002cx at the same epochs

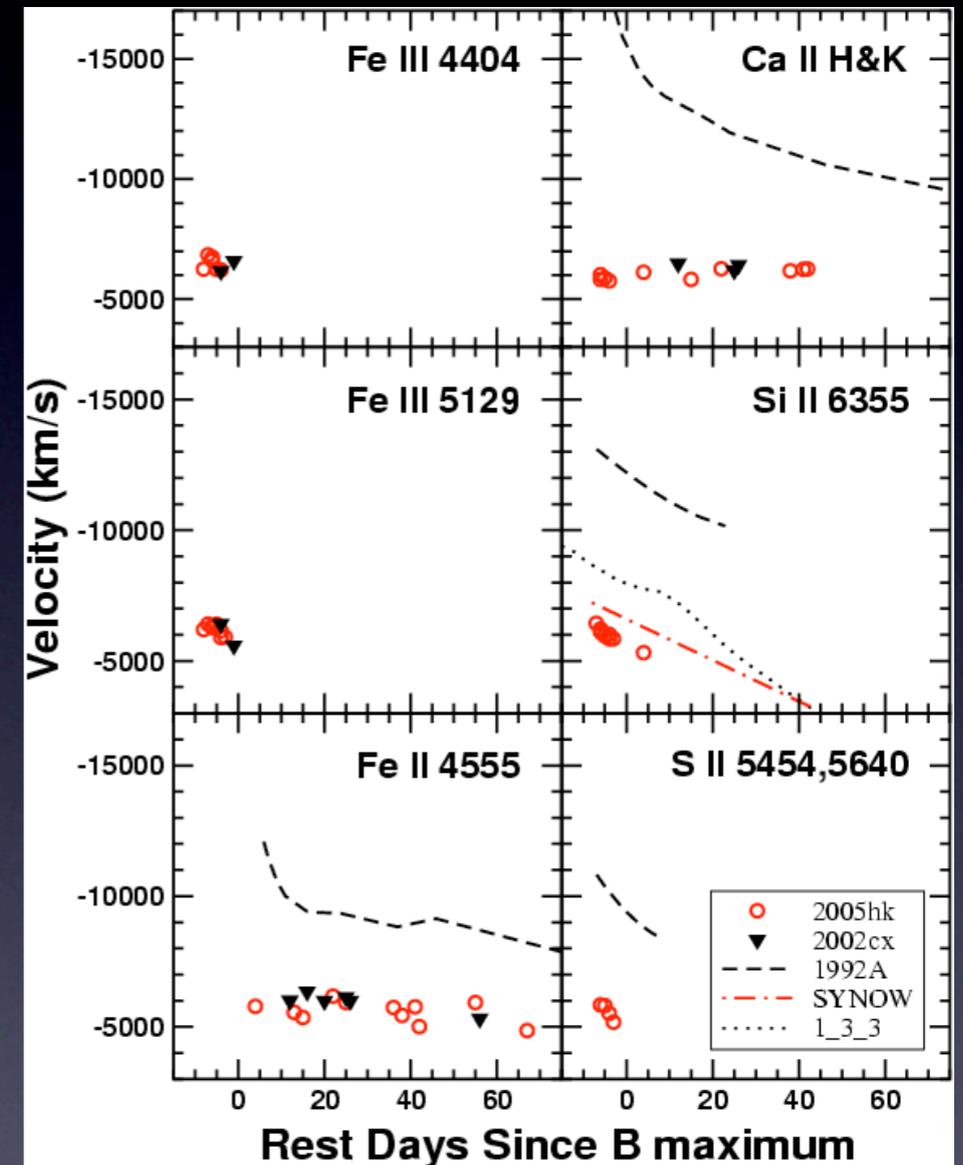


Phillips et al. 2006

Supernova 2005hk

Spectral properties:

- Very similar to SN 2002cx at the same epochs
- Low velocity of spectral features (factor of ~ 2) compared with normal type Ia SNe at different epochs



Phillips et al. 2006

Supernova 2005hk

Spectral properties:

- Very similar to SN 2002cx at the same epochs
- Low velocity of spectral features (factor of ~ 2) compared with normal type Ia SNe at different epochs
- Material is well mixed in the ejecta, with Iron and elements lighter than Iron present at all times

SN 2005gj

Light curve and spectra similar to 2002ic and 1997cy

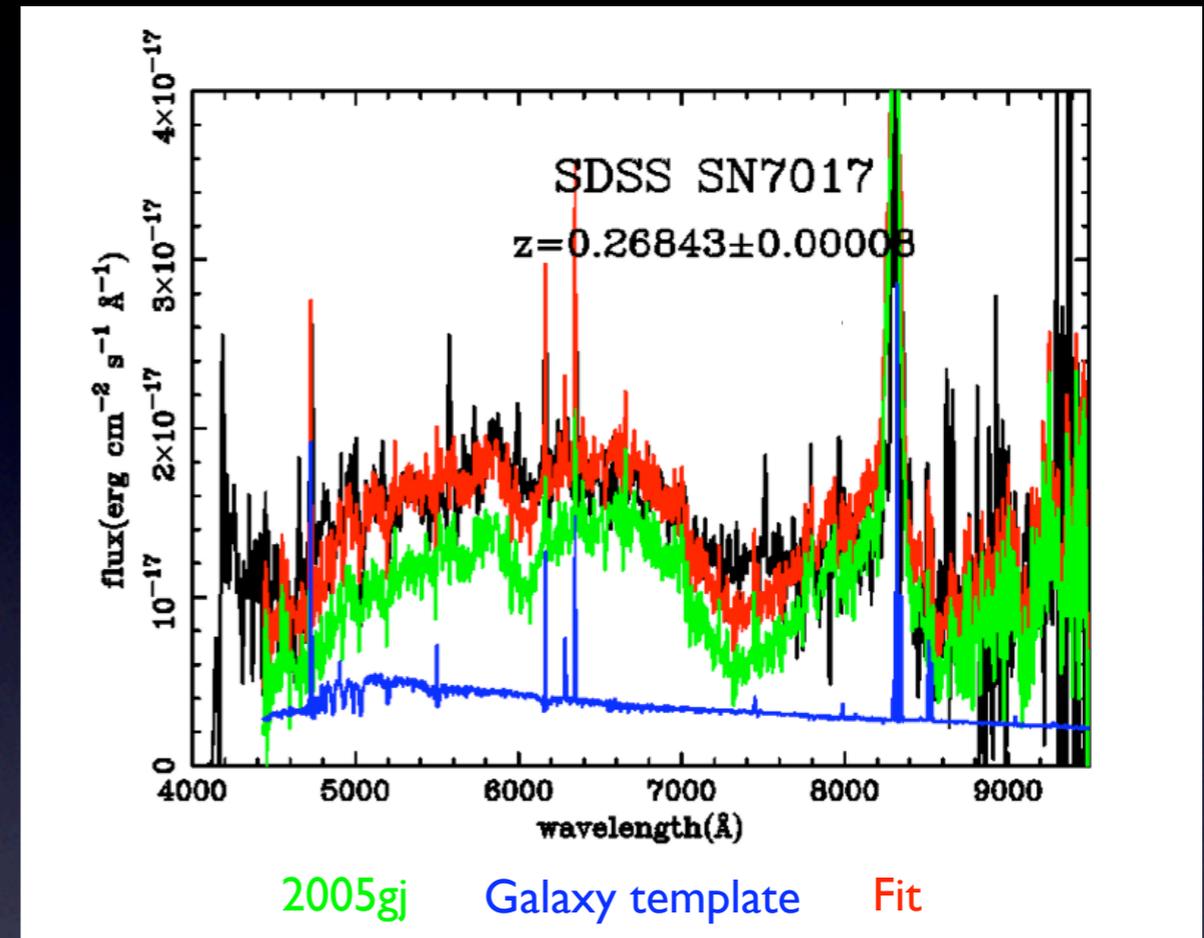
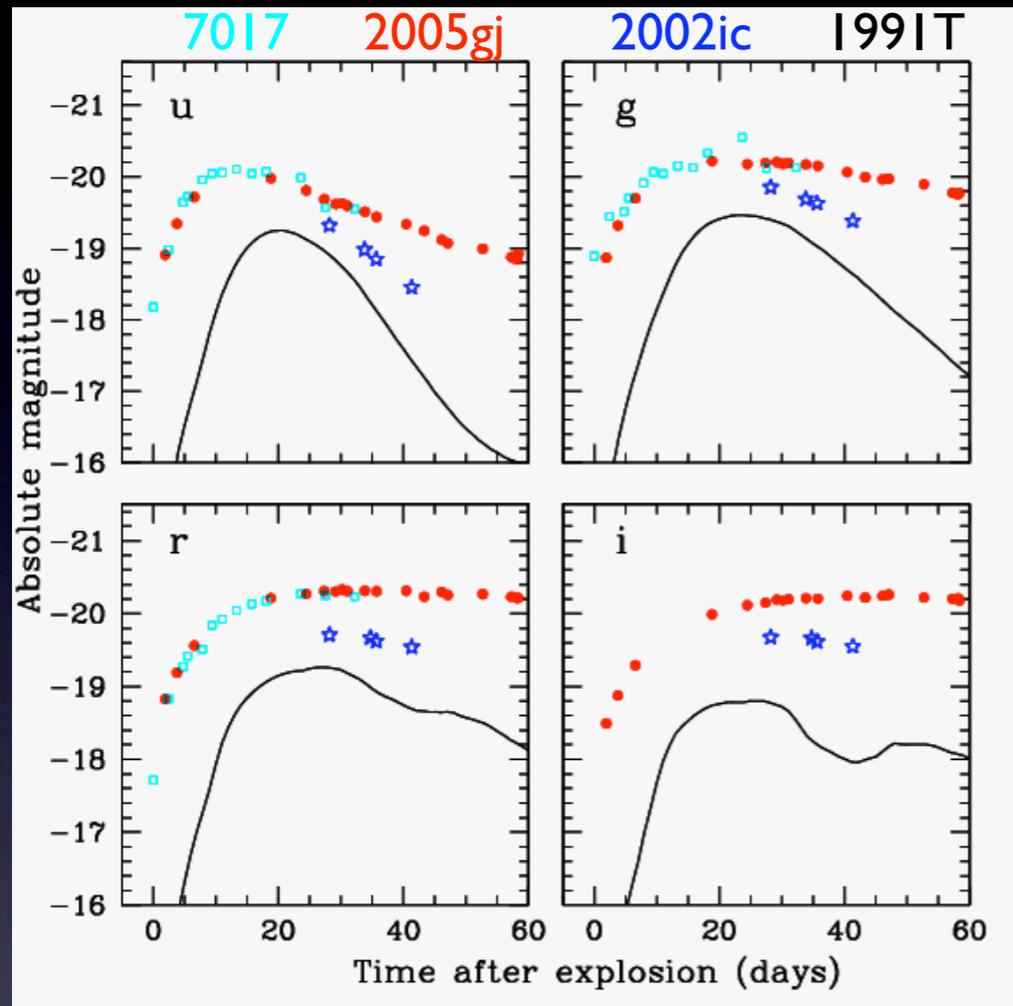
Best studied 2002ic-like SN, good evidence for the interpretation as a thermonuclear SN exploding in a dense CSM

SN 2005hk

Light curve and spectra very similar to 2002cx

The light curve properties are consistent with explosion as a pure deflagration

SN 7017: A High Redshift SN 2002ic-like Supernova ?



C. Zheng

- Spectrum very well-fit by SN 2005gj \sim 1 year after explosion at redshift $z=0.27$
- Light curve peaks at ~ -20.2 mag, almost clone of 2005gj in the first ~ 35 days after explosion !